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```
clear all;
close all;
```

B1

```
%If B = B1 = 0, the dynamics of the neural system are independent of
the
%modulatory input. Descriptively we see that x1 and x2 are periodic
and
%u2=1 has no influence on them.
```

```
index = 1;
b_vector= linspace(-1,1,5);
```

```
for j = 1:5
    % construct struct P of matrices A and B and vector C
    P.A = [-0.5,0;1,-0.5];
    P.B = createB(index,b_vector(j));
    P.C = [1;0];

    %define x0 at t = 0
    x0 = [0;0];

    %construct u
    u_vector = zeros(2,800);
    u_vector(2,301:601)= 1;
    u_vector(1,70:70:631)=5;

    % hrf model construction

    %hemodynamic state vector at t=0 (s,f,v,q)
    h0 = [0;1;1;1];

    % prameters for hrf : kappa, gamma, tau, alpha and E_0
    Phrf=[0.64,0.32,2,0.32,0.4];

    % compute dcm
    [y,h,x] = euler_integrate_dcm(u_vector,P,Phrf,x0,h0);

    % plot results
    t = linspace(0,80,800);
    figure;
```

```

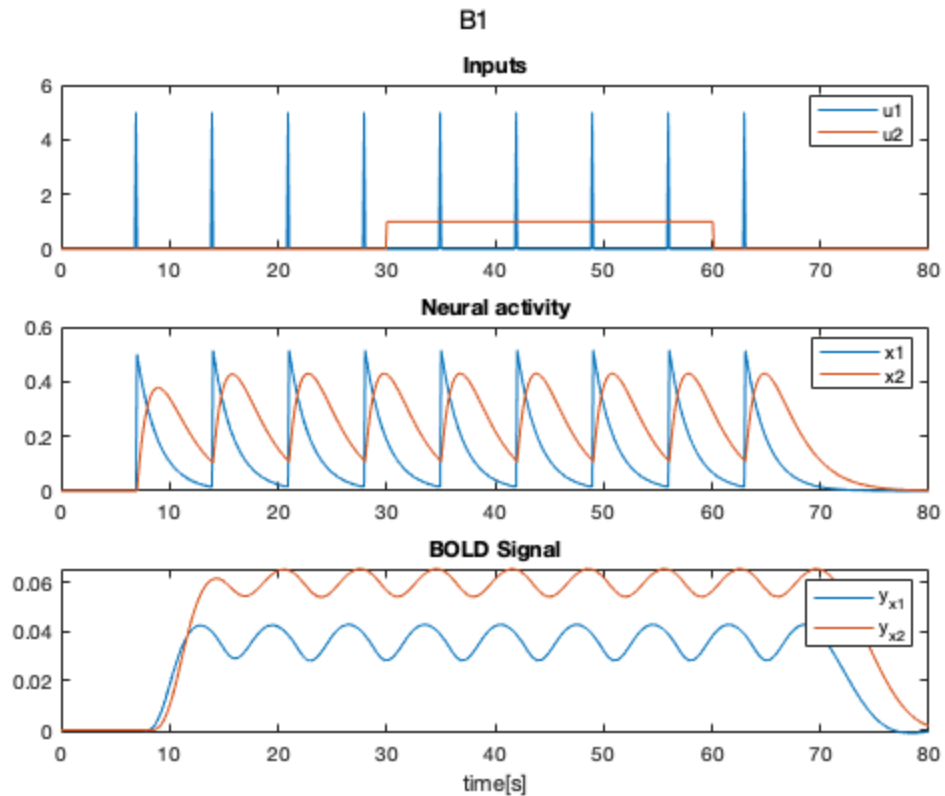
subplot(3,1,1);
plot(t,u_vector(:,:));
ylim([0,6]);
title('Inputs')
legend('u1','u2')

subplot(3,1,2);
plot(t,x(:,:));
%ylim([0,0.6]);
title('Neural activity')
legend('x1','x2')

subplot(3,1,3);
plot(t,y(:,:));
%ylim([0,0.08]);
title('BOLD Signal')
legend('Y_{x1}','Y_{x2}')
xlabel('time[s]')

if(index == 1)
    sgtitle(['B',num2str(index)])
    break;
else
    sgtitle(['B',num2str(index), ' with b =
',num2str(b_vector(j))])
end
end

```



B2

%If $B = B2$, the modulatory input influences the dynamics of the neural state $x2$, linked with the previous state $x1$. Descriptively we see that if $b > 0$, $u2 > 0$ has a positive impact on $x2$ ($x2$ increases) and $b < 0$, $u2 > 0$ has a negative impact on $x2$ ($x2$ decreases).

```
index = 2;
b_vector= linspace(-1,1,5);
```

```
for j = 1:5
    % construct struct P of matrices A and B and vector C
    P.A = [-0.5,0;1,-0.5];
    P.B = createB(index,b_vector(j));
    P.C = [1;0];

    %define x0 at t = 0
    x0 = [0;0];

    %construct u
    u_vector = zeros(2,800);
    u_vector(2,301:601)= 1;
    u_vector(1,70:70:631)=5;

    % hrf model construction
```

```

%hemodynamic state vector at t=0 (s,f,v,q)
h0 = [0;1;1;1];

% parameters for hrf : kappa, gamma, tau, alpha and E_0
Phrf=[0.64,0.32,2,0.32,0.4];

% compute dcm
[y,h,x] = euler_integrate_dcm(u_vector,P,Phrf,x0,h0);

% plot results
t = linspace(0,80,800);
figure;

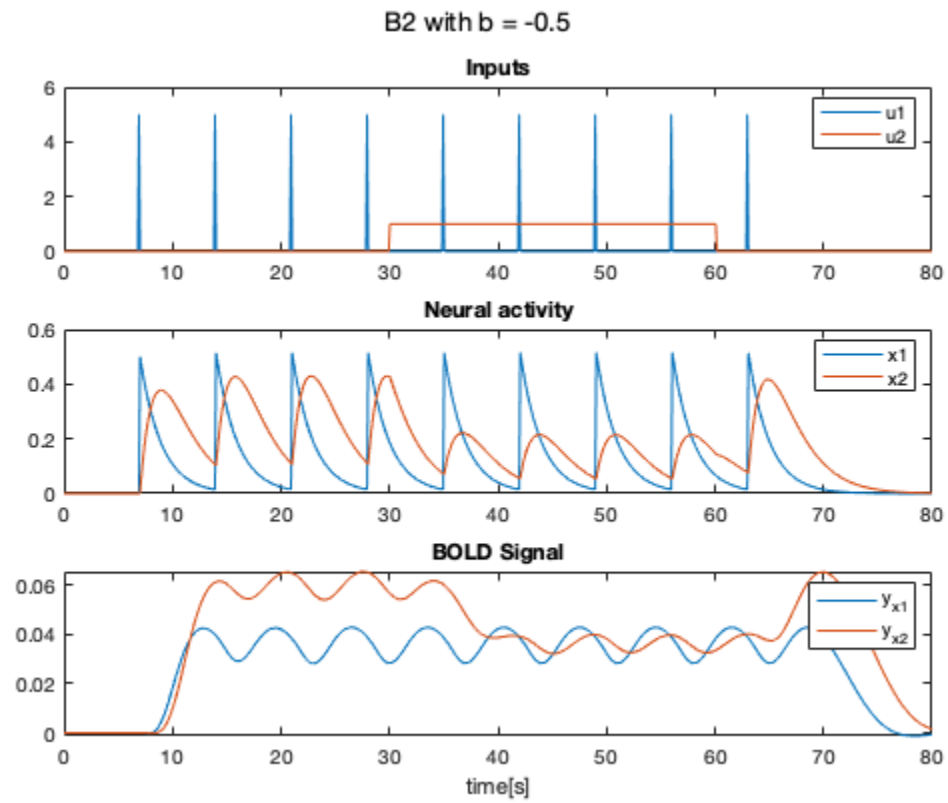
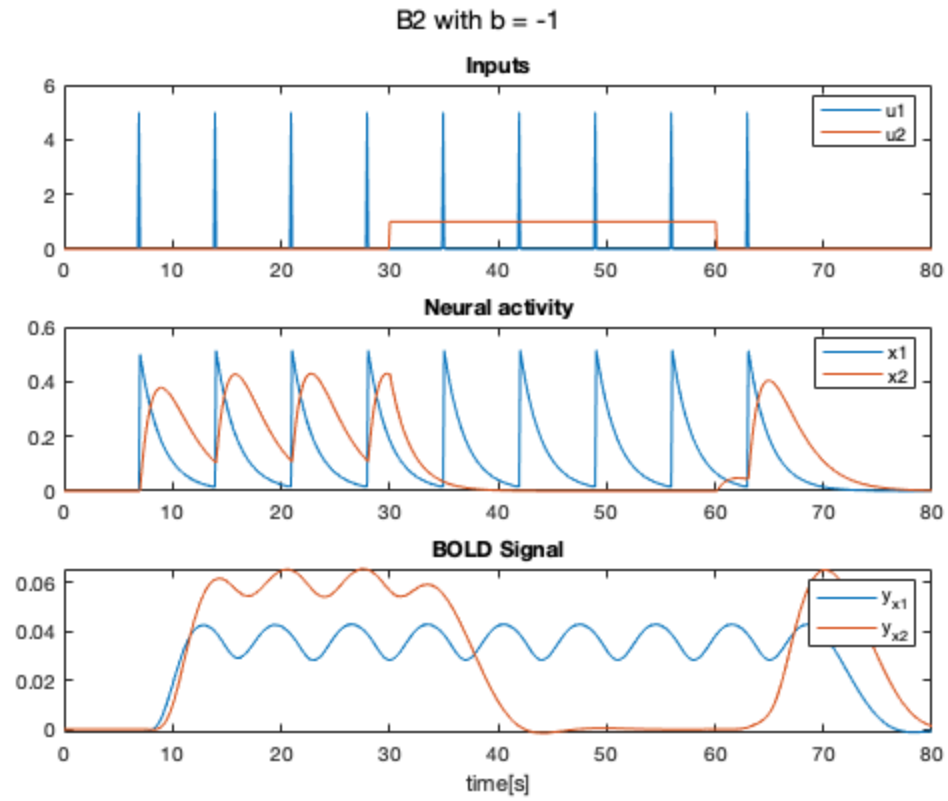
subplot(3,1,1);
plot(t,u_vector(:,:));
ylim([0,6]);
title('Inputs')
legend('u1','u2')

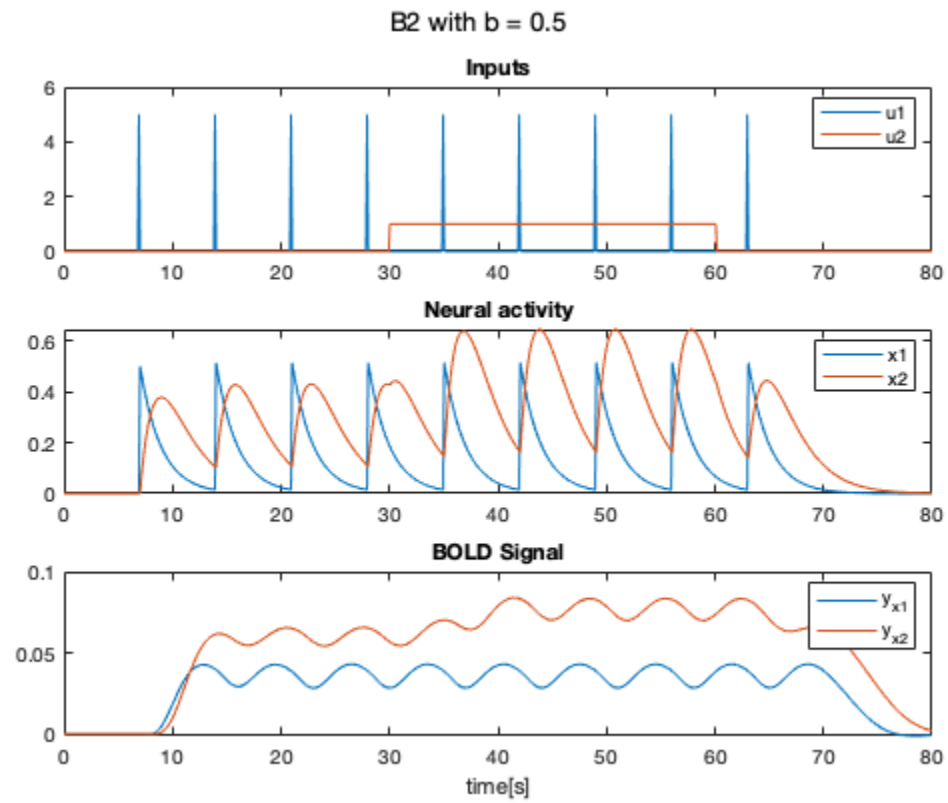
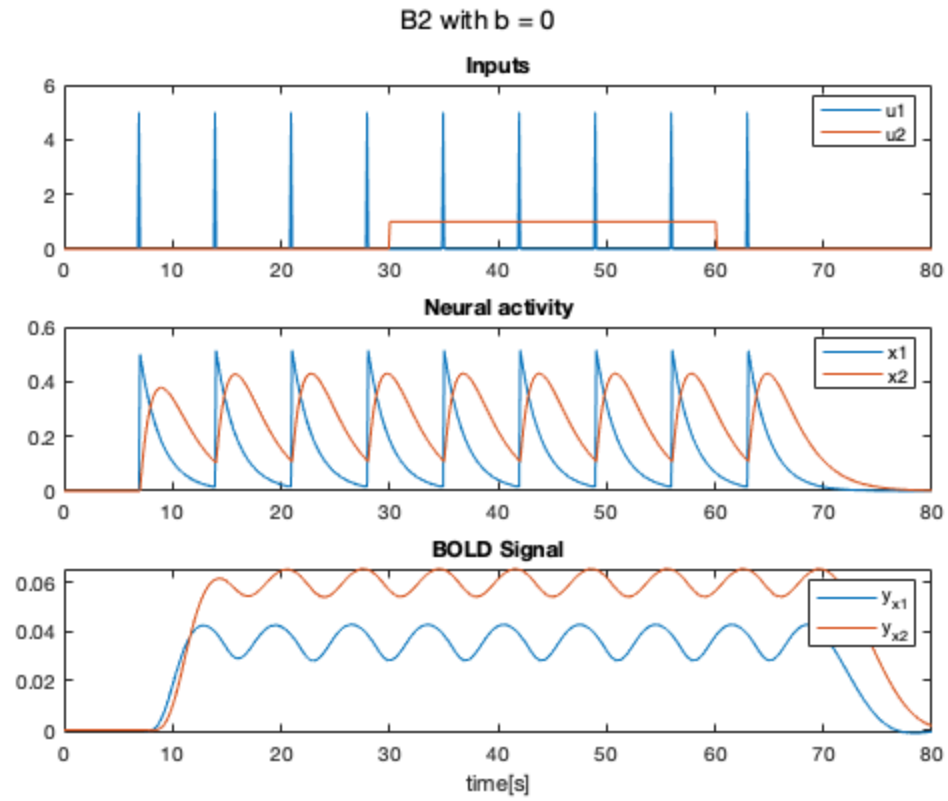
subplot(3,1,2);
plot(t,x(:,:));
%ylim([0,0.6]);
title('Neural activity')
legend('x1','x2')

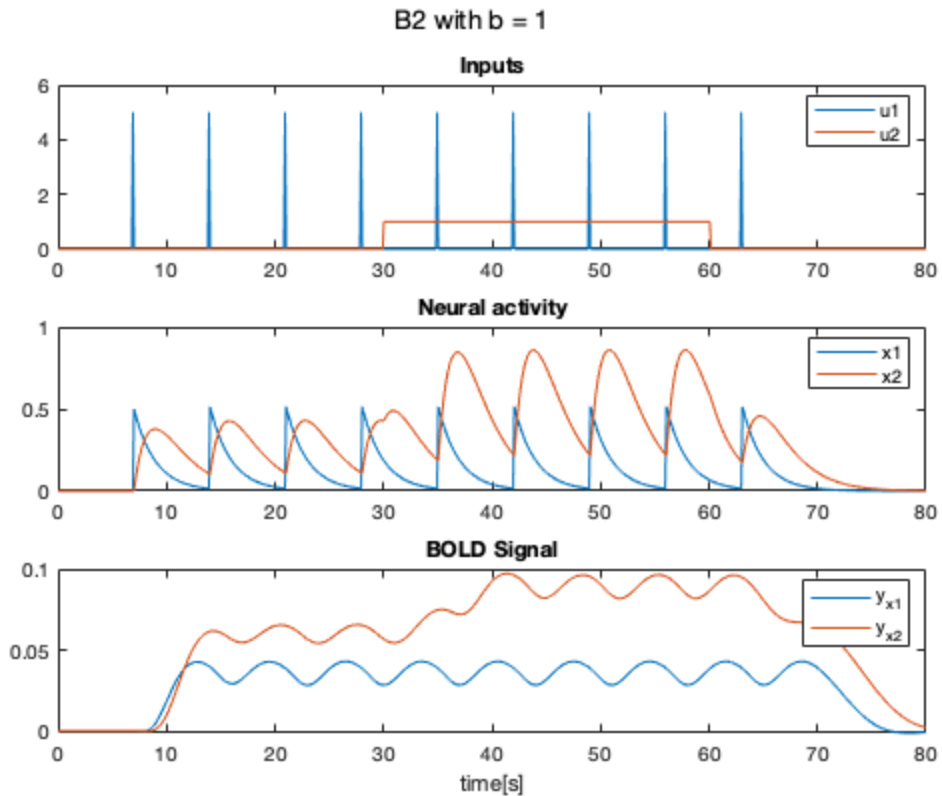
subplot(3,1,3);
plot(t,y(:,:));
%ylim([0,0.08]);
title('BOLD Signal')
legend('y_{x1}','y_{x2}')
xlabel('time[s]')

if(index == 1)
    sgtitle(['B',num2str(index)])
    break;
else
    sgtitle(['B',num2str(index), ' with b = ',num2str(b_vector(j))])
end
end

```







B3

```
%If B = B3, the modulatory input also influences the dynamics of the
state
%x2, linked with the previous state x2. Descriptively we see that if
b<0,
%u2>0 has a negative impact on x2 (x2 decreases). If b>0, the positive
impact of
%u2>0 is changed by setting the diagonal terms of (A+u2B) to
-0.5exp(a11+u2b11), for the stability of the system.
%This explains the negative impact of b=1 and the reduced positive
effect
%of b=0.5.
index = 3;
b_vector= linspace(-1,1,5);

for j = 1:5
    % construct struct P of matrices A and B and vector C
    P.A = [-0.5,0;1,-0.5];
    P.B = createB(index,b_vector(j));
    P.C = [1;0];

    %define x0 at t = 0
    x0 = [0;0];
```

```

%construct u
u_vector = zeros(2,800);
u_vector(2,301:601)= 1;
u_vector(1,70:70:631)=5;

% hrf model construction

%hemodynamic state vector at t=0 (s,f,v,q)
h0 = [0;1;1;1];

% prameters for hrf : kappa, gamma, tau, alpha and E_0
Phrf=[0.64,0.32,2,0.32,0.4];

% compute dcm
[y,h,x] = euler_integrate_dcm(u_vector,P,Phrf,x0,h0);

% plot results
t = linspace(0,80,800);
figure;

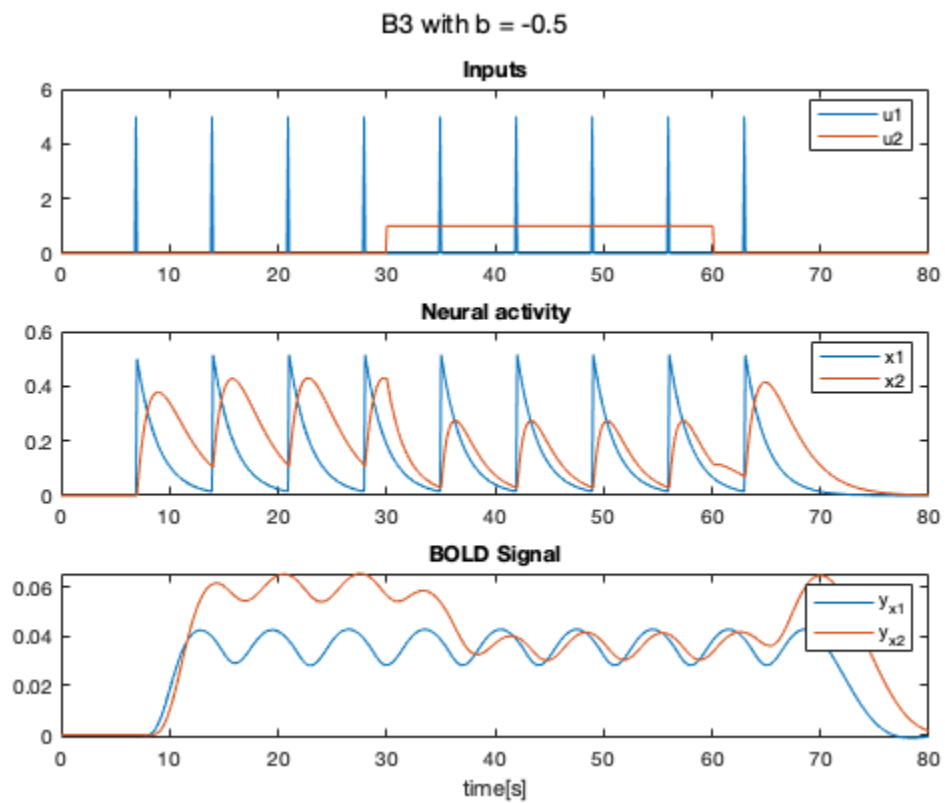
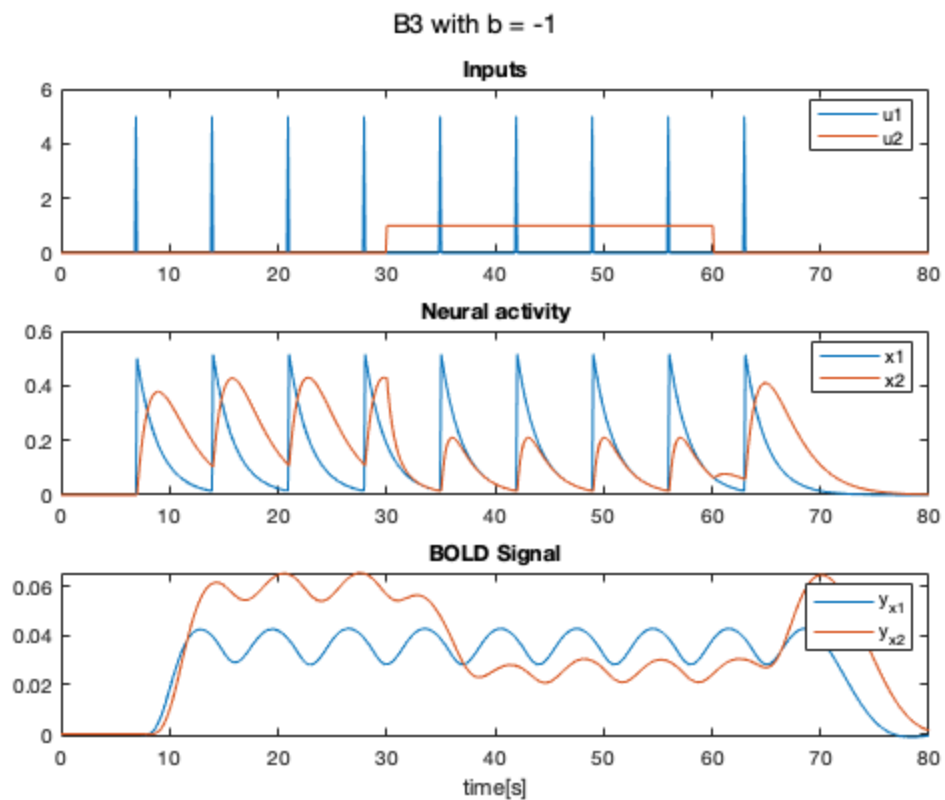
subplot(3,1,1);
plot(t,u_vector(:,:));
ylim([0,6]);
title('Inputs')
legend('u1','u2')

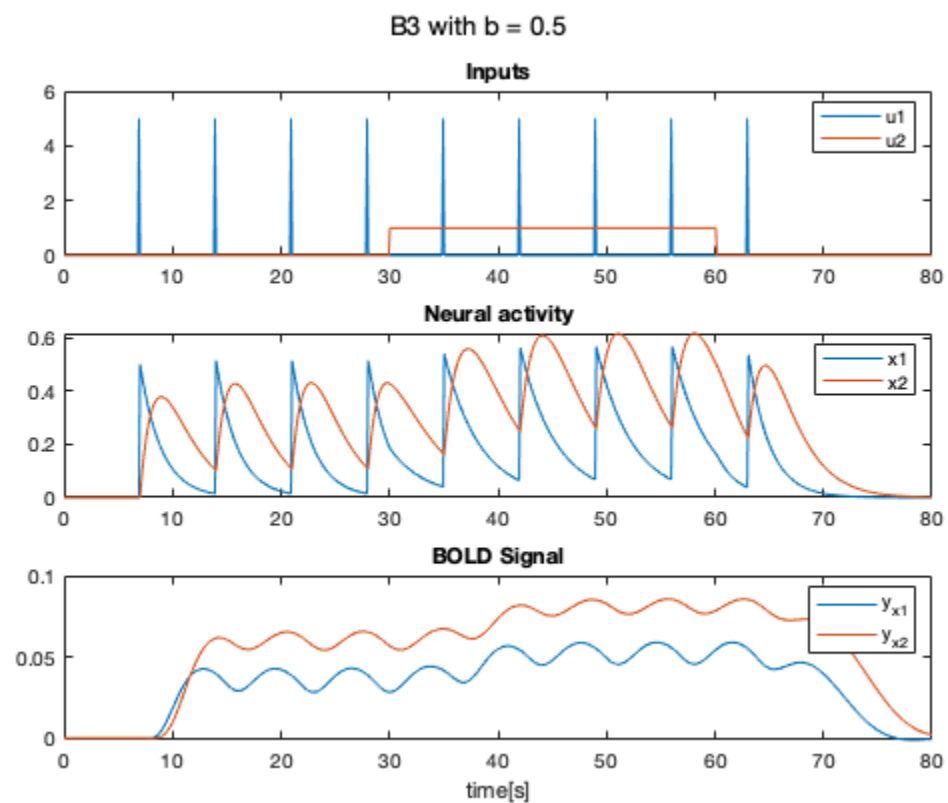
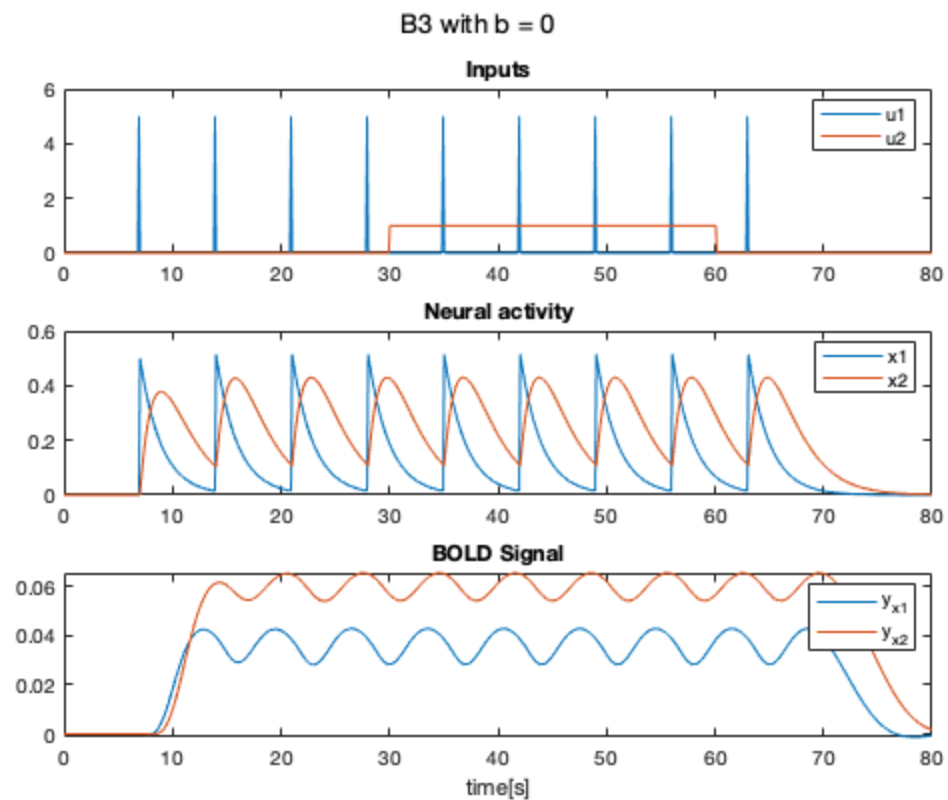
subplot(3,1,2);
plot(t,x(:,:));
%ylim([0,0.6]);
title('Neural activity')
legend('x1','x2')

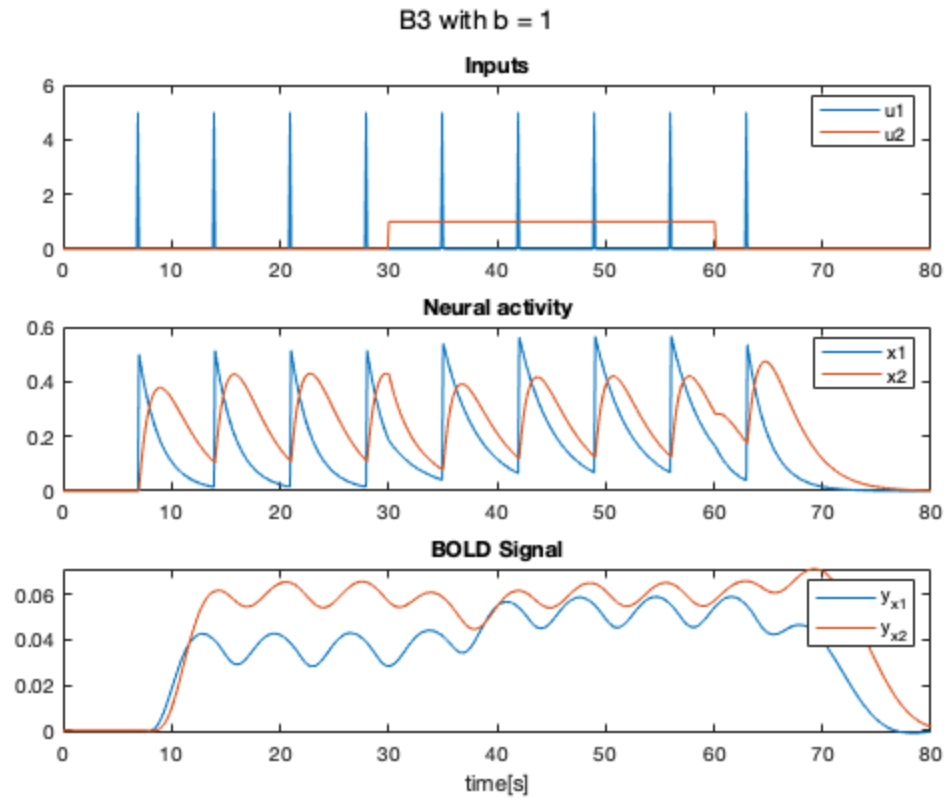
subplot(3,1,3);
plot(t,y(:,:));
%ylim([0,0.08]);
title('BOLD Signal')
legend('y_{x1}','y_{x2}')
xlabel('time[s]')

if(index == 1)
    sgtitle(['B',num2str(index)])
    break;
else
    sgtitle(['B',num2str(index), ' with b = ',num2str(b_vector(j))])
end
end

```







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